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Neutron Scattering Group

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Research Activities

(1) NEUTRON SCATTERING WITH TRIPLE AXIS SPECTROMETERS AT JRR-2-JAERI (TOKAI) and AT HFBR (BNL)

a. Spin Dynamics in Amorphous Ferromagnets (Y. Ishikawa, K. Tajima, S. Onodera and Z. Xianyu)

Spin dynamics of amorphous ferromagnets have been studied systematically in order to find the origin of the descrepancy between the magnon stiffness constant Ds and that determined by magnetization measurements D_M. It has been found that the amorphous Invar alloy $Fe_{86}B_{14}$ exhibits the anomalous spin dynamics which is similar to those found in the crystalline Invar alloys. In contrast with it, the spin dynamics in a non Invar amorphous $Fe_{70}Cr_{10}P_{13}C_7$ is quite normal; Ds agrees reasonably with D_M, from which we could conclude that the descrepancy between Ds and D_M in the amorphous ferromagnet is not the characteristic of the amorphous structure, but will be related with the Invar effect.

b. Observation of M-K fluctuations in a weak itinerant ferromagnet MnSi (Y. Ishikawa, Y. Noda, C.R. Fincher and G. Shirane)

Low energy paramagnetic excitations in MnSi have been studied by neutron scattering at HFBR of BNL. The generalized susceptivility $\chi(q)$ was determined

by integrating the energy spectrum of Lorentizian form $\Gamma/\Gamma^2+\omega^2$. $\chi(0)$ obey the Curie-Weiss law, while $\chi(q)$ has a strong q dependence. Γ varies with q and temperature T as $\Gamma \propto aq/\chi(q)$ as the M-K theory predicted. Thus the result provided the first experimental evidence of the presence of the M-K fluctutions in the weak itinerant ferromagnet.

c. Lattice dynamics in Invar alloys[7] (Y. Endoh and Y. Noda)

We extend the previous work on the lattice dynamical properties in the FeNi Invar to the antiferromagnetic iron alloys which show the similar Invar characters.

We found the elastic softening of the shear mode of $C_{11}-C_{12}$ which seems to be a common feature in iron Invar alloys regardless the type of the magnetic order.

d. Elastic anomalies in Fe_2TiO_4 [M1] (S. Saito and Y. Endoh)

We studied the unusual elastic properties in Fe_2TiO_4 which undergoes the crystallographic transition at 110 K due to the cooperative Jahn Teller Effect. Since the doubly degenerate orbitals are still unresolved below this temperature, the elastic constant remains small even at the lowest temperature.

e. Neutron diffraction studies[8)-12)] (Y. Endoh, J. Mizuki and Y. Ishikawa)

The continuous efforts to study the atomic structure the magnetic order, the phase transition and the magnetic excitations from the exotic materials or at the extreme condition such as high magnetic field, high pressure and etc. have been mode. Currently we have been studying the phase transition of the graphite intercalation, the spin density wave in Cr alloys and the random magnetic systems as the spin glass and oblique spin systems.

(2) NEUTRON SCATTERING WITH SPECTROMETERS AT KENS

a. Successful Start of KENS Facility[14] (Y. Ishikawa and all members)

We have devoted almost all of our times for the start of the KENS facility. The first neutron beams came out on June 18 and the neutron scattering experiments started from October 17. The characteristics of the normal neutron source[15], cold neutron source[16] as well as the neutron guide tubes[17] were measured. The 4th meeting of International Collaboration on the Advanced Neutron Sources (ICANS-IV) was held at KEK between 17 and 24 October[13].

b. Contruction and Performance of KENS small Angle Neutron Scattering Instrument (SAN)[18] (Y. Ishikawa, M. Furusaka, M. Arai and N. Niimura)

SAN is the small angle scattering instrument which is installed at the exit of the guide tube C_1. Equipped with a 2-D PSD counter and with fifteen He^3 counters set at six different positions and by utilizing the wave length ranging between 4Å and 12Å, the spectrometer can measure simultaneously the

scattering in a wide range of momentum transfer from 3×10^{-3} to 4 A^{-1}. The spectrometer is particularly useful for studying the long range structure in nonequilibrium state. The spinodal decomposition in FeCr alloys, the spin glass state in Cu_3Mn, and the helical spin structure in MnSi have been studied.

The investigation of polymer and biological materials is another important subject for SAN. The small angle scattering from Latex, Collagen (Chen) and Purple membrane have already been measured.

c. Construction and Performance of Multi-Analyzer Crystal Spectrometer (MAX)[19] (K. Tajima, Y. Ishikawa and K. Kanai)

MAX is the multianalyzer crystal spectrometer with inverted geometry which is equipped with fifteen analyzer crystals. The spectrometer was designed to perform energy scans along any desired direction in the reciprocal space and the complete magnon and phonon dispersions in a Brillouin zone can be measured at one time. The spectrometer is therefore quite effective for studying the time dependent collective excitations with the external disturbance. The magnon and phonon dispersions in a b.c.c. Fe(Si) crystal as well as the magnon dispersions in a f.c.c. FeMn crystal have been measured.

d. Test Experiment on Neutron Polarization by means of Polarized Proton Filter(Pre PEN)[M2](M.Ishida, J.M.Newsam, Y.Ishikawa, M.Kohgi & T.Nakajima)

In order to get insight into the technical problems concerning neutron polarization by means of polarized proton filter, the test experiments were performed using a diffractometer specially constructed for this purpose. The neutron polarization of 80 % was finally achieved for 88 meV neutrons. The method for preparing the filter materials was investigated and established.

e. Construction of the cold polarised neutron spectrometer TOP[5,20] (Y. Endoh, Y. Sasaki, M. Onodera, and H. Ono)

The time of flight spectrometer for the long wave polarised neutrons has been constructed at the end of the C3 neutron guide tube which is installed at the cold neutron source exit. This TOP spectrometer stands as the first pulsed polarised neutron spectrometer. Now it is operated for the versatile experiments such as the magnetic structure analysis of the long periodic materials, the diffuse magnetic scattering in the magnetic alloys, the paramagnetic scattering and so forth. Simultaneously we have developed the curved magnetic Soller mirrors which serve the high grade neutron polariser or polarisation analyser.

f. The interface magnetisation studies by means of the polarised neutron diffraction[6] (Y. Endoh and H. Ono)

The polarised neutron diffraction studies have been made using multilayered compounds of the sequential stacking of bilayers which consist of

magnetic and non magnetic films typically ≳ 100 Å thick.

We found that the polarisability of the refrected neutrons is particularly sensitive to the existence of the interface magnetisation which differs from the bulk magnetisation. We elucidate currently the effect of the interface on the ferromagnetic iron metals.

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16) KENS Cold NEutron Source, S. Ikeda, Y. Ishikawa and K. Inoue, ibid, 200.

17) Characteristics of KENS Cold Neutron Guide Tube, J. Mizuki, Y. Endoh, Y. Ishikawa and S. Ikeda, ibid, 521.
18) Small Angle Scattering Spectrometer, Y. Ishikawa, M. Furusaka, M. Arai, N. Niimura, S. Ikeda and K. Hasegawa, ibid, 563.
19) Multi-Analyzer Crystal Spectrometer at KENS, K. Tajima, K. Kanai, Y. Ishikawa, S. Tomiyoshi and C.G. Windsor, ibid, 600.
20) Time of Flight Spectrometer with Optical Polarizer, Y. Endoh, J. Mizuki, Y. Sasaki and H. Ono, ibid, 609.

Master Thesis (March 1981)

1) Neutron Polarization by Means of Dynamically Polarized Proton Filter, Masayoshi Ishida
2) Lattice Dynamics in Fe_2TiO_4 Studied by Neutron Scattering, Shuji Saito
3) Neutron Scattering under Non Equilibrium State, Takashi Shinohe